Technical Note

Arthroscopic Dissection of the Distal Semimembranosus Tendon: An Anatomical Perspective on Posteromedial Instability and Ramp Lesions

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Abstract: Ramp lesions are increasingly recognized as a hallmark of posteromedial knee instability. Although the precise mechanisms through which these lesions occur is not completely understood, the distal semimembranosus complex has been implicated in their pathogenesis due to its attachment to the posterior horn of the medial meniscus (PHMM). Arthroscopic dissection of the distal semimembranosus tendon, and the application of traction to it, results in posterior translation of the PHMM and stretching of the meniscocapsular region. This demonstrates a mechanism through which ramp lesions can occur. Furthermore, the subsequent open dissection highlights the complex anatomical relationships of the distal semimembranosus tendon complex, particularly its tensioning effect on the posterior oblique ligament. The clinical relevance of this is that when a ramp lesion occurs, it is likely to be part of a spectrum of posteromedial injury and it should be considered a hallmark of posteromedial instability rather than an isolated meniscocapsular injury.

Ramp lesions[1-4] are increasingly recognized as a hallmark of posteromedial knee instability. Several biomechanical studies have demonstrated that these injuries are associated with increased anteroposterior and rotational laxity and that their repair can result in restoration of normal knee kinematics. Although the precise mechanisms through which these lesions occur is not completely understood, the distal semimembranosus complex has been implicated in their pathogenesis due to its attachment to the posterior horn of the medial meniscus (PHMM). This has been demonstrated on both anatomical and imaging studies[5] (Fig 1 demonstrates the magnetic resonance imaging appearances of the relationship between semimembranosus and the PHMM). It is hypothesized that during an anterior cruciate ligament (ACL) rupture, excessive anterior tibial translation results in violent semimembranosus contraction and in turn this leads to excessive loading of the posteromedial structures of the knee (PHMM, meniscocapsular junction, meniscotibial ligament, posterior oblique ligament [POL]) resulting in the potential for injury and posteromedial instability.[5-8]

We present an arthroscopic technique for dissection of the distal semimembranosus tendon complex. This technique has both research and clinical implications for the management and study of posteromedial knee instability.

Surgical Technique

This cadaveric study was conducted in 2 parts. In the first part, the semimembranosus tendon and its

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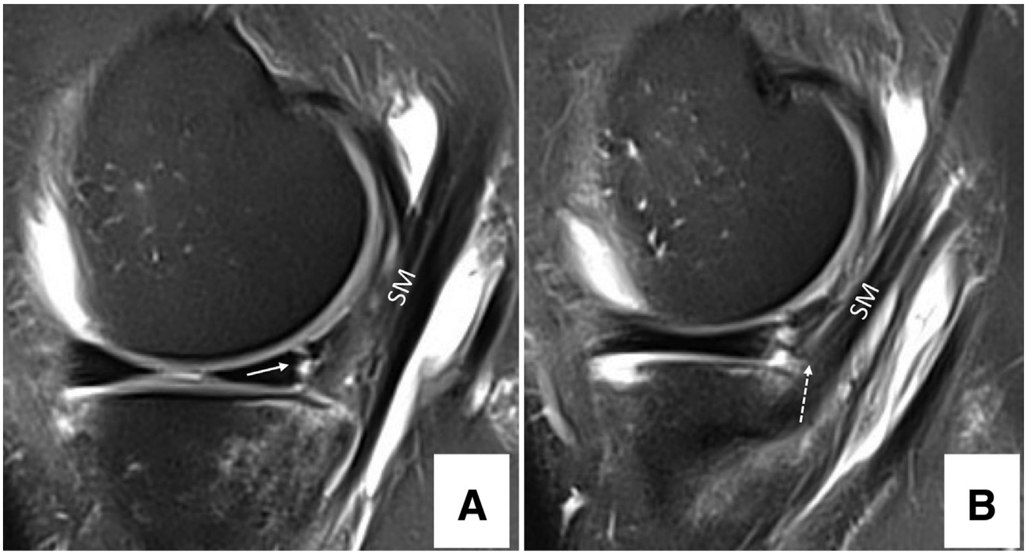

Fig 1. Right knee. Sagittal T2-weighted fat suppression magnetic resonance image. (A) Posterior medial meniscus lesion (white arrow) and its close relationship with semimembranosus tendon. (B) Semimembranosus insertion (white dotted arrow) in the posteromedial tibia plateau. (SM, semimembranosus.)

attachment to the posterior part of the medial meniscus were arthroscopically dissected. The influence of application of load through the semimembranosus was evaluated. In the second part, an open anatomic dissection of the posteromedial corner was performed to demonstrate the overall relationship with adjacent structures and attachments of the distal semimembranosus complex.

Step 1: Arthroscopic Identification—Transnotch Approach

After a standardized arthroscopic inspection of the joint, the knee was placed in 90° of flexion. Transnotch visualization of the posteromedial compartment was performed by introducing the arthroscope through the anterolateral portal in the triangle limited by the medial condyle, posterior cruciate ligament, and tibial spines. After the contact with this zone, the arthroscope can pass through the space at the condyle border when one is applying a valgus force in flexion.

Step 2: Transseptal Approach and Posteromedial Capsule Resection

The arthroscope was placed through the anteromedial portal, under the ACL, and into the posterolateral compartment. A posterolateral portal was created using the needle localization technique (posterior and proximal to the popliteus tendon). The shaver was introduced through the posterolateral portal and pushed under the septum. The arthroscope was switched from the anteromedial to the anterolateral portal to visualize the septum. The shaver was pushed through the septum, into the posteromedial compartment, under

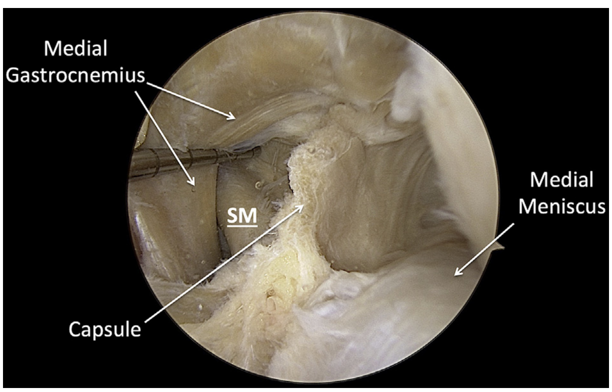

Fig 2. Right knee. Transnotch view of the posteromedial compartment after partial capsulectomy. (SM, semimembranosus tendon.)

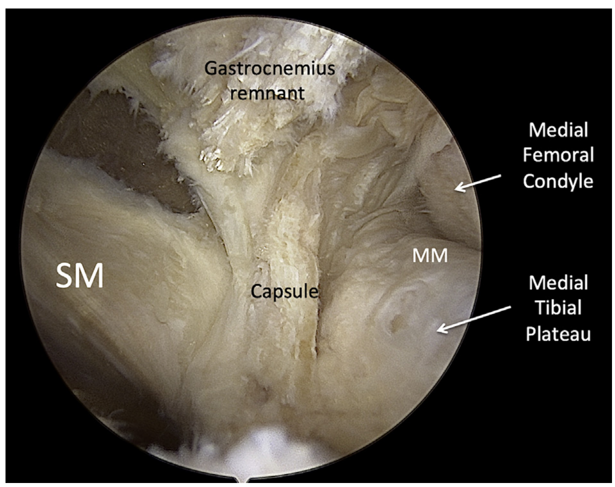

Fig 3. Right knee. Transseptal view of the posteromedial compartment after gastrocnemius section. (SM, semimembranosus tendon.)

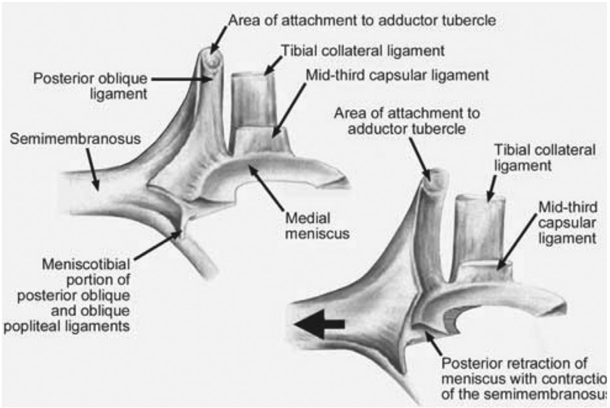

Fig 4. Original drawing from Sims and Jacobson.[8] Intracapsular orientation of the posteromedial corner structures showing the proposed dynamizing action (arrow) of the semimembranosus. Note the relationship of the semimembranosus capsular expansion, the posterior oblique ligament, and the posteromedial meniscus (reprinted with permission).

direct arthroscopic visualization. The posteromedial capsule was resected from medial to lateral.

Step 3: Medial Gastrocnemius and Semimembranosus Identification

The medial gastrocnemius tendon and the semimembranosus tendon were identified by a combination of probing structures through the posteromedial capsule and then by direct visualization after its resection (Fig 2). The medial gastrocnemius tendon was sectioned at its femoral insertion, facilitating exposure of the semimembranosus tendon (Fig 3) and revealing its anatomical relationships with the adjacent structures described by Sims and Jacobson[8] (Fig 4). An arthroscopic suture passer (Knee Scorpion; Arthrex, Naples FL) was used to place a suture within the semimembranosus tendon for the purposes of identification at open exploration and also to allow an assessment of the outcomes of application of load to the semimembranosus on other structures in the posteromedial aspect of the knee.

Step 4: Arthroscopic Evaluation of the Kinematics of the Semimembranosus Tendon and the Posteromedial Corner

The suture that was placed in the semimembranosus tendon was then retrieved externally. The influence of application of load to the distal semimembranosus complex (via the suture) on the posteromedial corner was evaluated arthroscopically during knee flexion and extension (Video 1).

Step 5: Posteromedial Corner Dissection

An open anatomic step-by-step dissection of the posteromedial corner was performed to confirm the correct identification of the semimembranosus tendon and its neighboring structures (Figs 5 and 6). The skin and superficial soft tissues were excised. The sartorius fascia, gracilis, and semitendinosus tendon

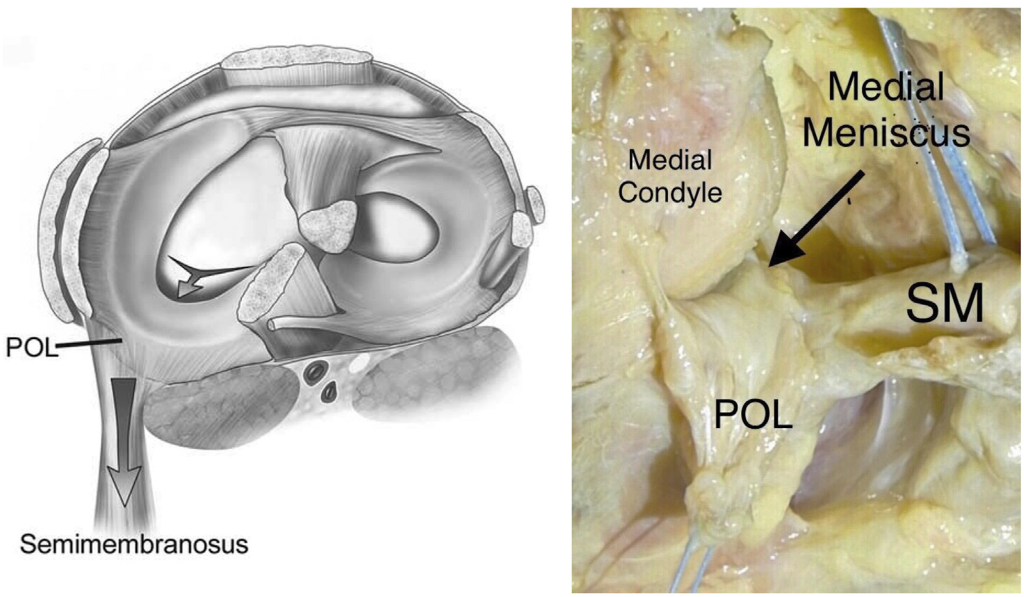

Fig 5. On the left, the scheme proposed by Sims and Jacobson[8]: bird's-eye view of the proposed dynamizing action of the semimembranosus. The large arrow represents tension created in the posterior meniscocapsular complex by the semimembranosus. Note the ability of the semimembranosus to tension the posterior oblique ligament (POL) and aid in posterior meniscal retraction, represented by the small arrow (reprinted with permission). IOn the right, the anatomic dissection of the posteromedial corner show on the left. (SM, semimembranosus tendon.)

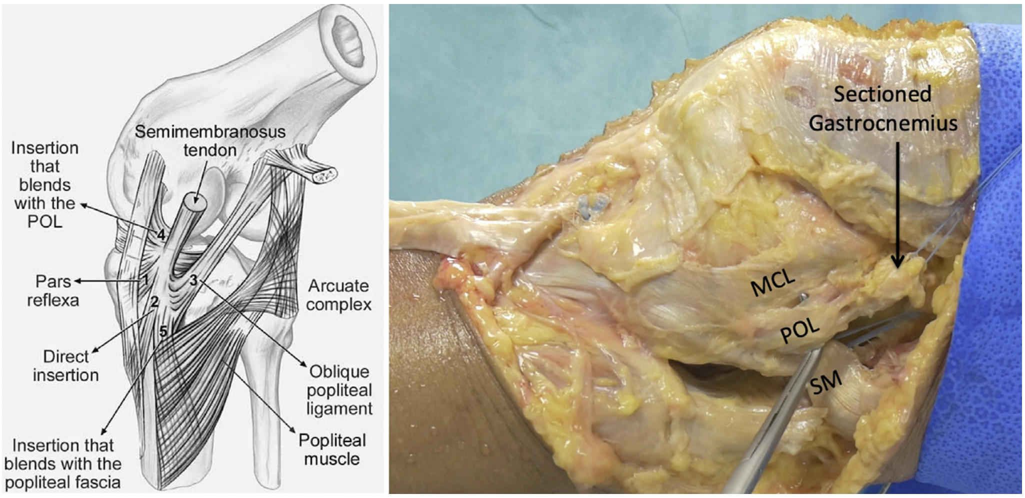

Fig 6. On the left, the original drawing from Sims and Jacobson[8]: the semimembranosus expansions. The 5 insertions are (1) pars reflexa, (2) direct posteromedial tibial insertion, (3) oblique popliteal ligament insertion, (4) expansion to posterior oblique ligament (POL), and (5) popliteus aponeurosis expansion. Note the investment into the POL (reprinted with permission). On the right, the anatomic dissection of the posteromedial corner, right knee (MCL, medial collateral ligament; POL, posterior oblique ligament; SM, semimembranosus tendon.).

were reflected. The medial collateral ligament and POL were identified. The previously placed sutures and normal anatomy were used to identify the semimembranosus. The proximal POL was detached and reflected to visualize the strong connection between the semimembranosus and the medial meniscus. Traction on the semimembranosus demonstrated this attachment as well as the tensioning effect it has on the POL (Video 1).

The pearls and pitfalls of this arthroscopic dissection are given in Table 1, and the advantages and disadvantages of this dissection are given in Table 2.

Discussion

The structural arrangements of the distal semimembranosus tendon and its expansions form the anatomical basis of posteromedial knee instability, including the pathophysiology of ramp lesions. Specifically, at arthroscopic evaluation, the application of load to the semimembranosus tendon resulted in posterior translation of the PHMM and stretching of the meniscocapsular region. This finding is consistent with the work of several previous authors.[6,7]

In 1962, Kaplan[6] reported that posterior displacement of the medial meniscus during knee flexion occurs as a result of both passive displacement by the femoral condyles and active contraction of the semimembranosus. Hughston,[7] in 1993, suggested that the semimembranosus insertion to the posteromedial capsule may stress the peripheral meniscus, resulting in meniscocapsular tearing and posteromedial corner and medial meniscal instability. Similarly, Sims and Jacobson[8] identified and described posteromedial injury patterns that may occur as a result of the dynamizing action of the semimembranosus tendon in posterior meniscal retraction.

More recently Yoon et al.[9] hypothesized a "contrecoup mechanism" of injury. The authors suggested that excessive anterior translation of the tibia during an ACL rupture would result in a reflex contraction of semimembranosus and that this could explain the high incidence of associated ramp lesions. This hypothesis is compatible with work from Saygi et al.[10] who proved the presence of a reflex arc between the medial meniscus and the semimembranosus muscle. The authors demonstrated that electrical stimulation of the

Table 1. Pearls and Pitfalls

	Pearls	Pitfalls
Transseptal approach	Allows visualization and dissection of the far medial part of the semimembranosus through the posterolateral approach.	By making the posterolateral portal too posteriorly, one may not properly reach the posteromedial corner. By opening the capsule too distally, one could erroneously resect the semimembranosus expansions to the posterior horn of medial meniscus.
Dissection of the medial gastrocnemius tendon	The medial gastrocnemius tendon should be dissected from its femoral insertion for better visualization of the semimembranosus tendon.	By cutting the gastrocnemius tendon too distally, one could also erroneously resect the semimembranosus expansions.

Table 2. Advantages and Disadvantages

Advantages	Disadvantages
Allows arthroscopic visualization of the relationship between the distal semimembranosus tendon complex and the posterior horn medial meniscus/meniscocapsular junction.	Cadaveric model. Gastrocnemius tendon requires resection for optimal visualization of the distal semimembranosus tendon.
No need for extensive dissection. Provides a technique that can be used for future biomechanical studies of posteromedial instability without the need for disrupting normal anatomical relationships by an open dissection.	No biomechanical analysis was performed in this study.

PHMM produced an electroneuromyography-verified response of the semimembranosus muscle. Subsequently, Akgun et al.[11] reported that mechanical stimulation of the posterior horn receptors during flexion or rotation of the rabbit knee joint also causes semimembranosus muscle contraction and therefore posterior translation of the medial meniscus.

Despite the consistent message in the literature that the semimembranosus tendon and the PHMM share an important relationship, the current dissection study is the first to demonstrate this relationship arthroscopically. Furthermore, the subsequent open dissection highlights the complex anatomical relationships of the distal semimembranosus tendon complex, particularly its tensioning effect on the POL. The clinical relevance of this is that when a ramp lesion occurs, it is likely to be part of a spectrum of posteromedial injury and it should be considered a hallmark of posteromedial instability rather than an isolated meniscocapsular injury.

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